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Astrium's views on OOS & ADR

**European On-Orbit Satellite Servicing and
Active Debris Removal Conference**

October 30, 2012 Brussels, Belgium

Didier ALARY // 30th Octobre 2012

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Astrium: part of EADS – a global leader in aerospace and defence

EADS



Airbus
Airbus Military

Eurocopter

Astrium

Cassidian

Astrium Satellites

Astrium Services

Space Transportation

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On-Orbit Servicing & Active Debris Removal

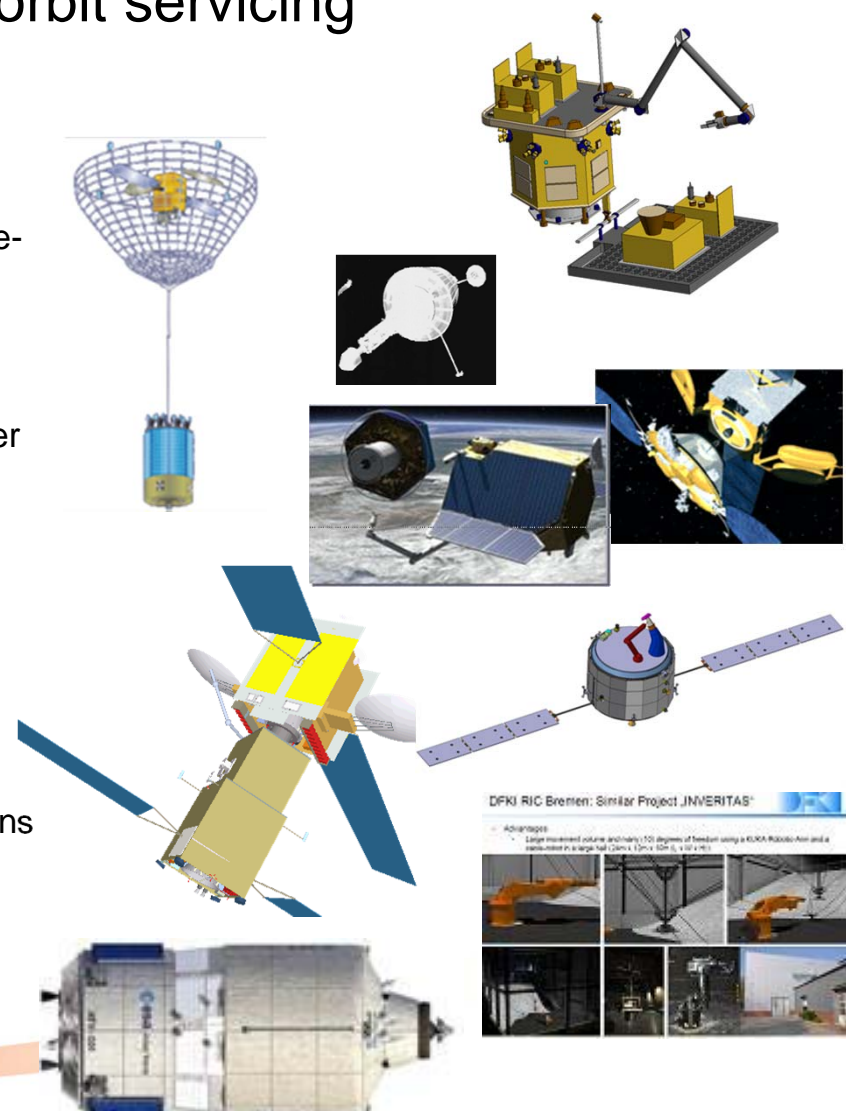
- Capabilities & Heritage
- Servicing & ADR prospects
- Business cases



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Astrium has a strong heritage in relevant studies and spacecraft missions related to on-orbit servicing

- Many studies before 1999 (ESS, GSV, SIRE...)
- FFMO (1999-ESA) Free Flying Micro Satellite - ISS Servicing
- ROSS (2000-DLR) ROsat Service Satellite - Controlled de-orbit of ROSAT
- SNAP inspection (2000), In Orbit Demo
- Conexpress Orbital (2002-ESA) GEO satellite life extension/transfer to graveyard
- **ROGER** (2003-ESA) ROBotic GEostationary orbit Restorer - Active debris removal – Net capture
- **SSBB** (2005-ESA) Satellite Servicing Building Blocks – System study & ground demos
- **TECSAS/DEOS** (2002-DLR) DEutsche Orbital Servicing Mission - Demo of capture technology
- Tether gripper (patent)
- **InVeritas** (2012 – DLR): Technology Development for Rendezvous, Capture and Berthing
- **RTES** (ongoing – DLR): Maturation of Rendezvous, Capture and Berthing technologies for commercial missions
- **VAC** versatile vehicle (ESA)
- **OTV** (ongoing – CNES)
- Automated Transfer Vehicle **ATV** (ongoing – ESA): operational automated on-orbit servicing



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And we are ready to go further...

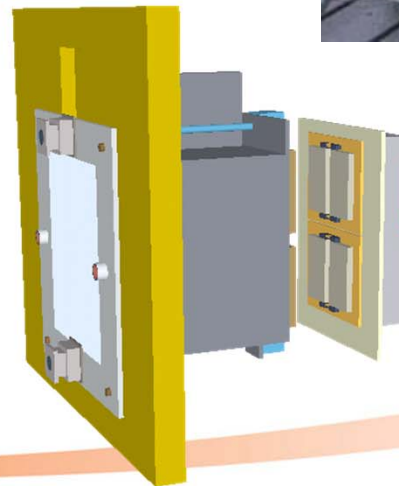
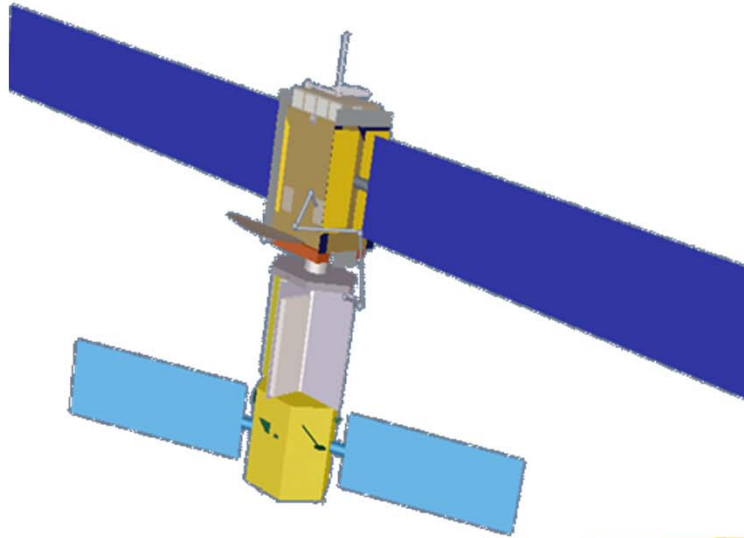
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Satellite Servicing Building Blocs



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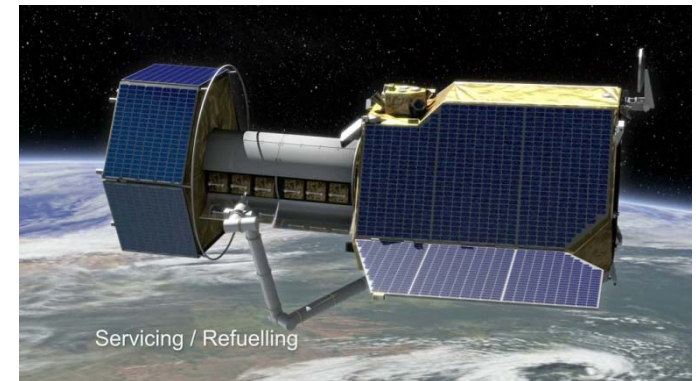
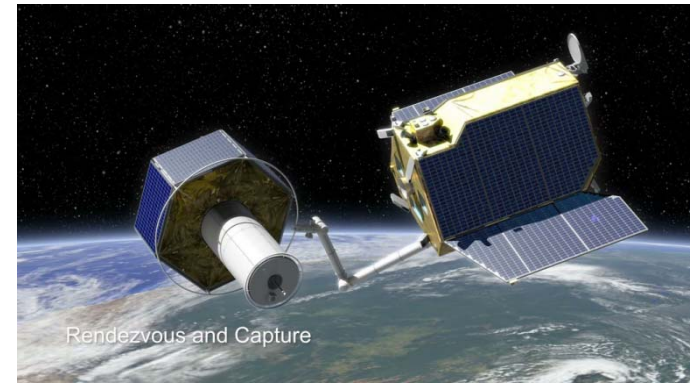
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The DEOS program



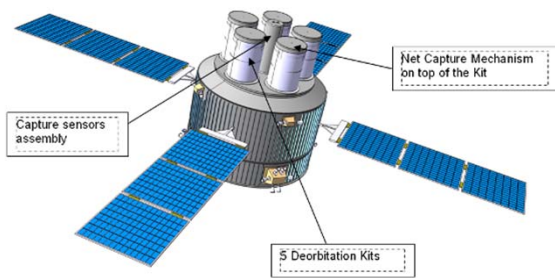
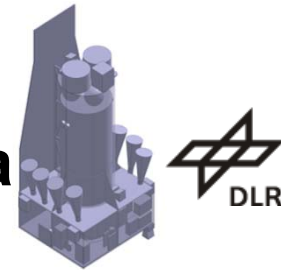
- The DLR DEOS Program is currently in Phase B2.
- Main goal is to perform a Demonstration Mission for Rendezvous and Capture by a manipulator system with an target in LEO.
- Astrium has been selected to prime the phase B2.



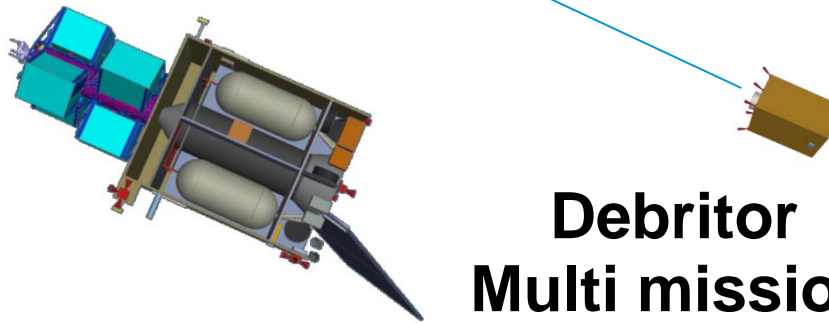
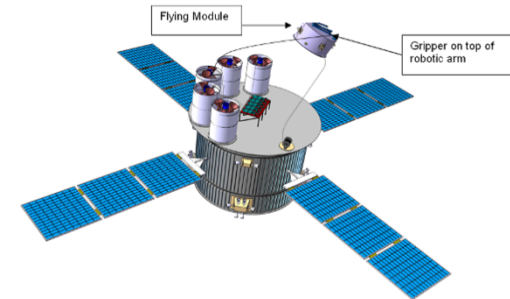
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ADR – Possible Missions

Single Satellite removal with Vega



VAC Multimissions



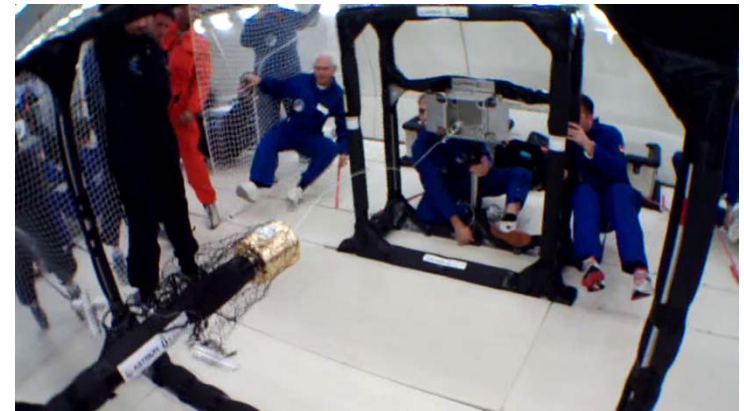
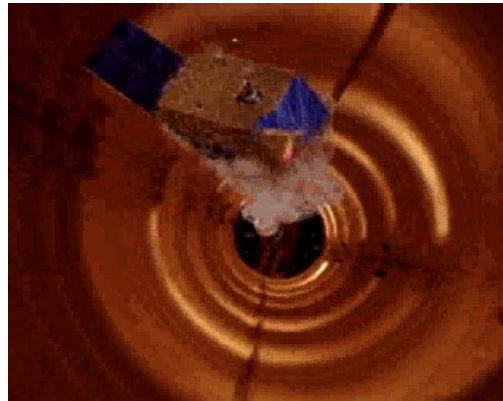
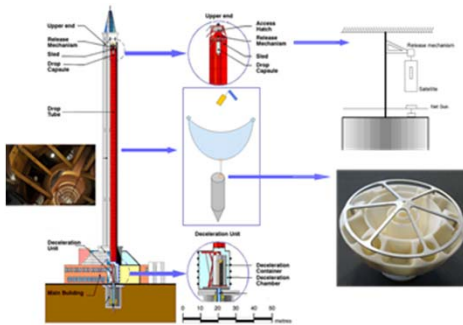
Debritor Multi mission Concept



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Net Capture

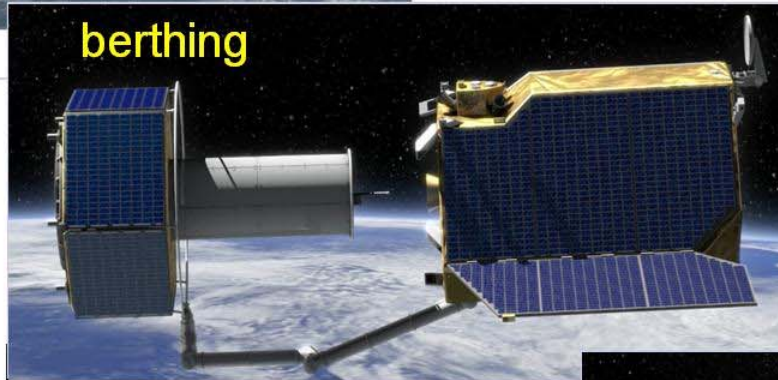
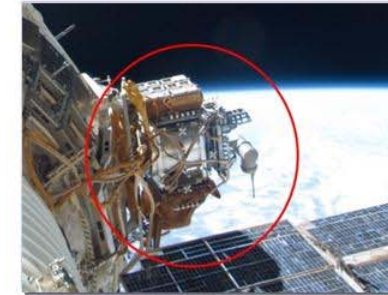
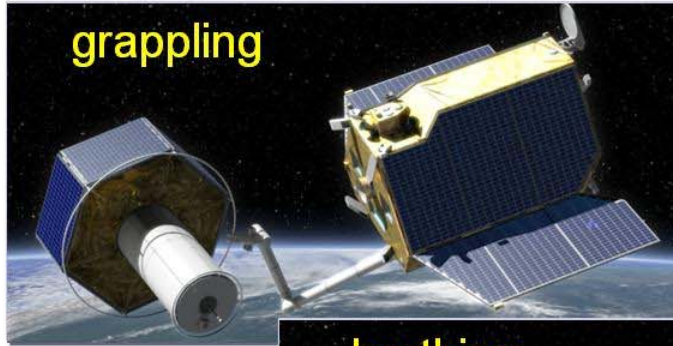
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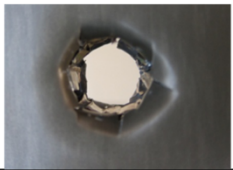

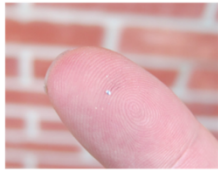


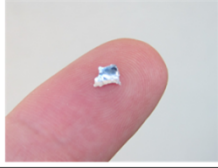
Robotic Arm Capture

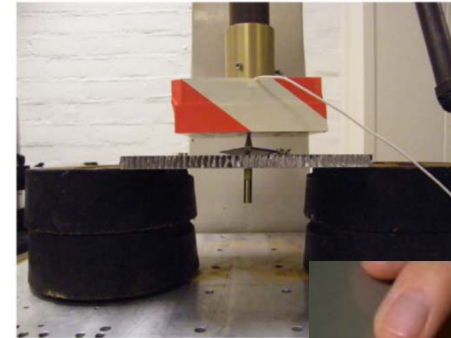
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Harpoon capture

	Front face	Rear face	Debris creation
AOO=0°			
AOO=45°			



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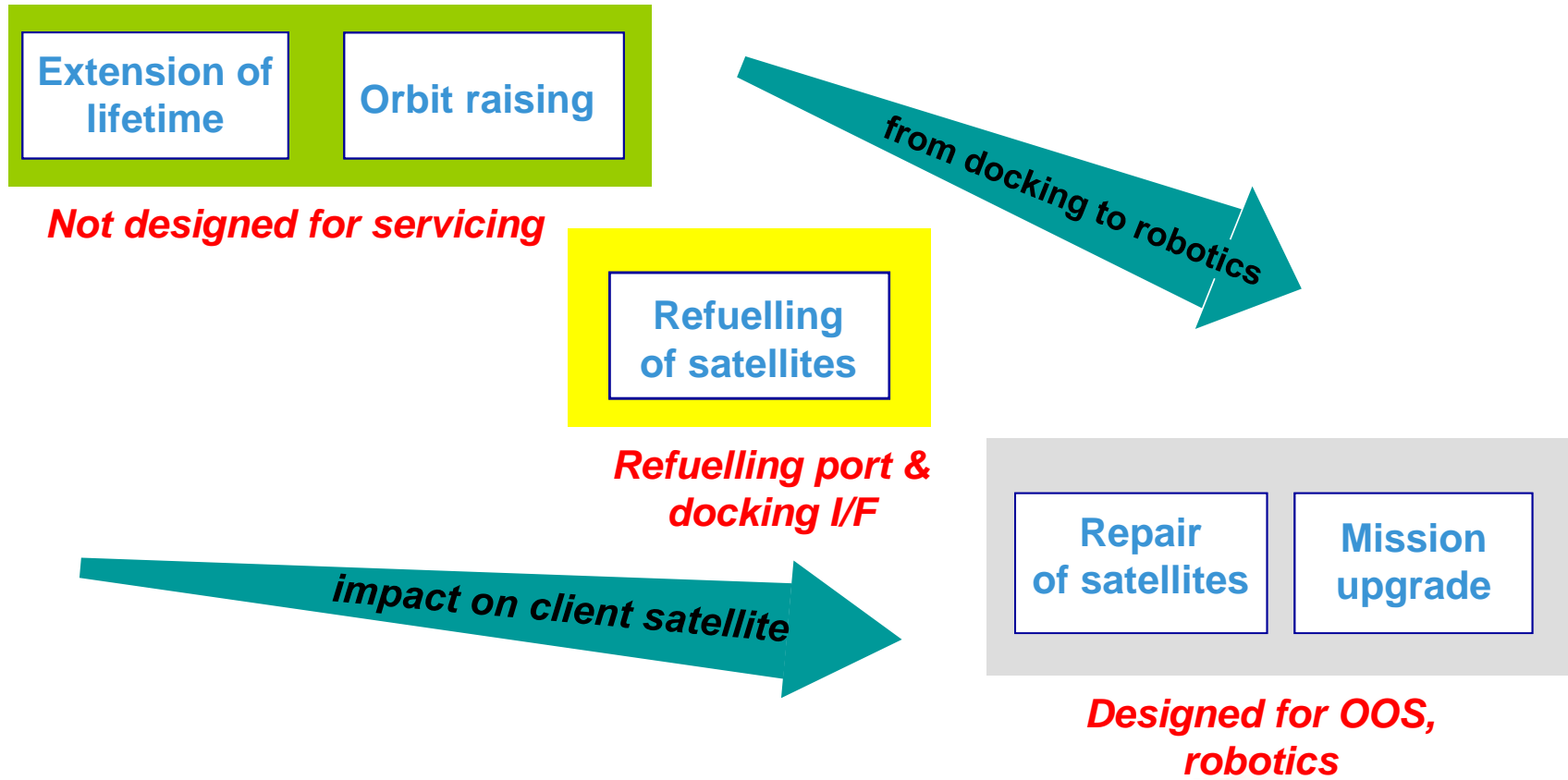
Business Cases

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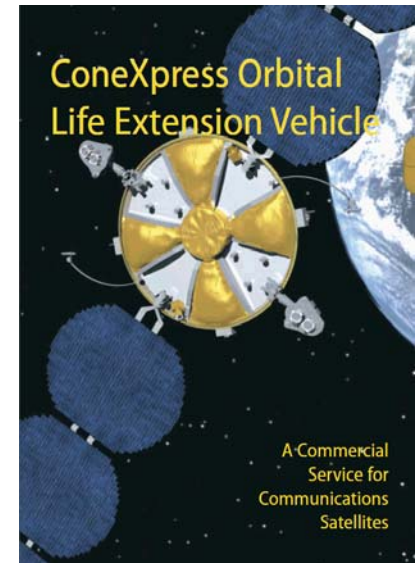
Possible On Orbit Servicing missions

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Potential OOS Missions - Life extension

- Mainly in GEO
- Space tug to move a satellite
 - To another operational position
 - To restore orbital inclination and node
 - To graveyard, removing zombies...
- Fostering the second hand market
- Additional self standing missions
- Many studies since a decade, several start-ups.



Potential OOS Missions – Refueling

- On Orbit refuelling is identified mainly in GEO
 - ATV is refuelling the ISS !
- And mainly to increase satellite lifetime
 - At the end of the life, to extend an existing solid market, or to start a new market.
 - Eventually recover a satellite injected on the wrong orbit
- It will require std interfaces and docking port, and new risks to be mitigated
- Many possible advanced concepts : fuel depot, space tanker...

Possible OOS Missions – Maintenance

- Maintenance
 - Replacement of equipment (computer, solar arrays...),
 - Demonstrated several times in LEO with the shuttle (mainly HST, it was designed for IOS), or with OrbitalExpress Darpa program,
- Evolution/Adaptation/Upgrades
 - Ex: exchange of an antenna to modify the coverage,
 - Preferably at payload level → Fractionated concept,
- The satellite has to be designed accordingly
 - Mass and cost penalty,
 - New techniques for connections, thermal control, physical architecture...

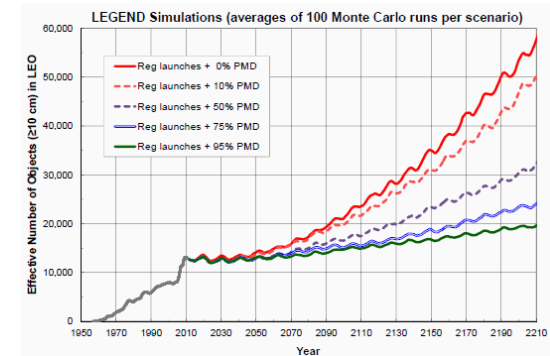


Possible ADR missions

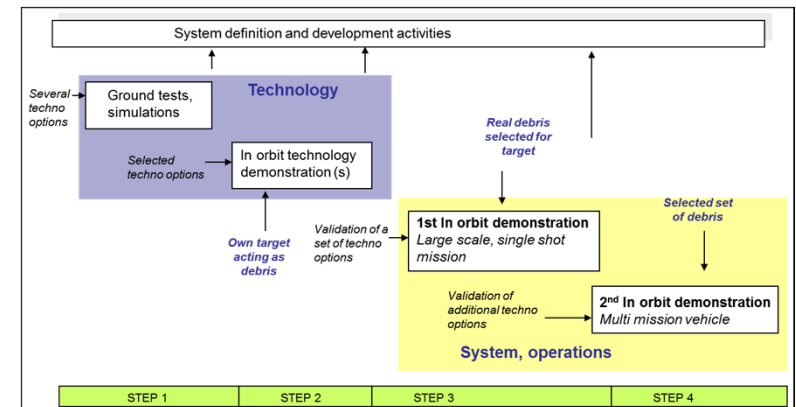
- Removal a dead body (satellite or Rocket body)
 - To lower the collision rate/debris generation
 - Legal issues
 - The **only** chance to maintain/reduce the debris population in the next decades and ensure the **long-term sustainability** of space.

- Complex mission
 - No single solution
 - Stepped approach
 - Demonstrations phases

- A removal commercial service ?
 - Third option after self PMD (most efficient) and de-orbit pack in piggyback.
 - Mostly dependent on the cost of removal



Credit NASA debris quarterly news – oct 2012



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Summary

- Astrium has growing experience and capabilities for On-Orbit Servicing – both robotic and human-tended,
- The business case for On-Orbit Servicing needs to be developed, but missions will be needed.
- Active Debris Removal is a strategic axis for mission concepts and technological bricks, Astrium is investing.
- Active Debris Removal is a mandatory mission to ensure long term sustainability of space domain.

